WRIGHT, S.E. and R.A. DOLBEER. 2000. Wildlife strikes: a growing and costly problem for civil aviation in the USA. Pages 35-52 in Proceedings of the 45th Annual Corporate Aviation Safety Seminar (San Antonio, TX, April 25-27, 2000).

Wildlife Strikes: A Growing and Costly Problem for Civil Aviation in the USA

Sandra E. Wright
U.S. Federal Aviation Administration Wildlife Strike Database

Richard A. Dolbeer
National Wildlife Research Center

Attribution

We thank the following people for their assistance in providing support for this paper: E.C. Cleary, FAA Office of Airport Safety & Standards, Washington, D.C., S.K. Agrawal and M. Hoven, FAA Technical Center, Atlantic City, N.J. The Federal Aviation Administration provided sponsorship and funds for this research. Opinions expressed in these studies do not necessarily reflect current FAA policy decisions governing the control of wildlife on or near airports.

The authors also wish to thank S.C. Barras, E.C. Cleary, and M.E. Tobin for reviewing this paper.

Introduction

Wildlife strikes, defined as aircraft collisions with birds or other animals, are a serious safety and economic concern in the USA and elsewhere. Liability issues related to wildlife strikes are also growing for airports and aircraft operators. In this paper, we will give examples of some significant strikes, show trends in wildlife strikes, explain why the strike problem is an increasing concern and discuss what actions can be taken to reduce and prevent strikes.

Significant Strikes

The loss of at least 327 aircraft and 321 lives has occurred worldwide from bird or other wildlife strikes to aircraft since 1912 (1,2,3,4,5,6,7). Surprisingly, deer strikes have not resulted in any known fatalities but have destroyed 13 aircraft in the USA since 1983 (8).

The first fatal bird strike was in 1912. Cal Rodgers, the first person to fly across the USA, was cruising along the California coast in his Wright Flyer when he flew through a flock of gulls. One of the gulls jammed his flight controls and Rodgers' aircraft crashed into the Pacific Ocean (6).

The worst bird strike to civil aircraft occurred in October 1960. A Lockheed Electra departing Boston Logan Airport flew through a flock of European starlings (*Sturnus vulgaris*). One engine shutdown and then two other engines lost power. Sixty-two people were killed when the aircraft plunged into Boston harbor. Ten people survived (6).

In 1973, a Learjet 24 with seven people on board struck a flock of about 20 brown-headed cowbirds (*Molothrus ater*) just after takeoff from Atlanta's DeKalb Peachtree Airport. Everyone on board was killed in the crash (6).

A DC-10 was destroyed by fire when it flew through a flock of gulls on takeoff at John F. Kennedy International Airport in 1975. One engine had an uncontained failure and shrapnel from that engine punctured the fuel tank. Luckily, all 139 on board were airline employees who had been trained in evacuation. Everyone escaped (6).

The worst U.S. military strike occurred in September 1995 at Elmendorf Air Force Base, in Alaska. An E3-AWACS struck a flock of Canada geese (*Branta canadensis*) on takeoff, which caused compressor stalls in the number 1 engine and failure of the number 2 engine. The geese had been flushed toward the runway by the departure of a previous aircraft minutes before. Tower personnel saw the geese, but did not warn the AWACS crew of the danger. All 24 on board perished in the resulting crash (7,8).

Recently, (January 1998) a Delta B-727 departed Houston Intercontinental Airport, Texas. While climbing to 6,000 feet above ground level (AGL) the aircraft struck a flock of snow geese (*Chen caerulescens*) and began to shudder. The noise level in the cockpit made communication very difficult. The number 1 engine was destroyed and the number 2 and 3 engines were severely damaged. The radome was torn off, the radar antenna was lost and the right wing had extensive damage. An emergency landing was made (9).

Aborted takeoffs due to wildlife strikes have resulted in aircraft damage and injuries. In 1996, a Southwest Airlines B-737 aborted takeoff at Nashville International Airport, Tennessee after an American kestrel (*Falco sparverius*) was ingested into the number one engine. During the aborted takeoff, the tires deflated, the brakes caught fire and the aircraft left the runway. Five passengers were injured, one seriously, while deplaning on the emergency chutes (9).

Serious accidents also occurred when pilots attempted to avoid striking birds or deer. In 1997, the pilot of an F-16 swerved sharply to avoid a flock of birds and collided with the AT-38B trainer flying next to him. The trainer was destroyed and both crew died in the crash. The F-16 pilot managed to land his damaged aircraft at Edwards AFB. In 1996, a deer darted in front of a Cessna 182 as it was on short final for an airport in Idaho. The pilot pulled up to avoid the deer and collided with a fence post at the edge of the airstrip. The aircraft flipped over and suffered substantial damage. (9)

Synopsis of Wildlife Strikes to Civil Aircraft in the USA 1990–1998

The FAA, through an interagency agreement with the US Department of Agriculture, National Wildlife Research Center, initiated a project in April 1995 to obtain more objective estimates of the magnitude and nature of the wildlife strike problem nationwide for civil aviation. This project included: 1) editing all strike reports (FAA Form 5200-7) sent to the FAA since 1990; 2) entering all edited strike reports in a Wildlife Strike Database; 3) supplementing FAA-reported strikes with additional reports from other sources; and 4) assisting the FAA with the production of an annual report summarizing the results of the database analyses (10). The latest report is available at the FAA's wildlife hazard Web site (www.faa.gov/arp/hazard.htm).

A total of 22,935 (2,548/year) strikes (Table 1, page 45) were reported for USA owned aircraft or strikes that occurred in the USA from 1990-1998. Ninety-seven percent of the strikes involved birds, about 3% involved mammals and less than 1% involved reptiles. About 95% of the strikes involved commercial and corporate aircraft (Table 2, page 46). Most strikes occurred between July and October (Table 3, page 46). Fifty-three percent occurred during approach or landing and 39% occurred during takeoff and climb (Table 4, page 46). Over half the strikes occurred at an altitude under 100 feet AGL, 78% occurred under 900 feet AGL and 87% occurred under 2,000 feet AGL (Table 5, page 47).

The aircraft components most often struck by birds were windshield, engine, wing/rotor and nose. The components most often damaged by birds were the engine, wing/rotor, radome and windshield (Table 6, page 48). Of the 22,935 strikes that were reported, 16,283 indicated there was no damage, 2,086 reported minor damage and 1,268 resulted in substantial damage. Nineteen aircraft were destroyed (Table 7, page 49). About 14% of the bird strikes adversely affected the flight compared to 64% for mammal strikes (Table 8, page 49).

During the 9-year period, 1990-1998, reported losses from bird strikes totaled 97,813 hours of aircraft down time and $67.63 million in aircraft damage and associated costs. Mammal strikes resulted in 65,854 hours of aircraft down time and $6.78 million in aircraft damage and associated costs.

Of the 5,011 reports that indicated the strike had an adverse effect on the aircraft or flight, only 988 provided an estimate of the down time (average 166 hours/incident) and only 759 provided an estimate of the cost (average $139,000/incident). The FAA estimates that less than 20% of all strikes were reported based on studies done at three major airports. Also, many reports that were filed with the FAA did not contain data regarding cost and time out of service. Therefore, the actual number of strikes and costs compiled from this voluntary system of reporting underestimates the problem.

Assuming that all of the 5,011 strikes that adversely affected the flight or damaged the aircraft incurred similar amounts of down time and monetary losses, the minimum cost from strikes to the USA civil aviation industry was 92,233 hours/year in down time and $77.19 million/year in monetary losses. If the 20% reporting rate is taken into account, the cost can now be estimated at 461,165 hours/year in down time and $385.95 million/year in monetary losses.

Why The Strike Threat Is Increasing

The number of wildlife strikes to civil aircraft reported annually in the USA more than doubled from 1,739 strikes in 1990 to 3,636 in 1998 (10). This increase is likely due a combination of an increased reporting rate and an increase in wildlife strikes. The number of civil aircraft destroyed by strikes increased from 4 in the 1960s to 22 in the 1990s (Figure 1) (1). However, the number of fatalities from these strikes declined over the same period. Fatalities for the military have, on the other hand, increased (Figure 2).

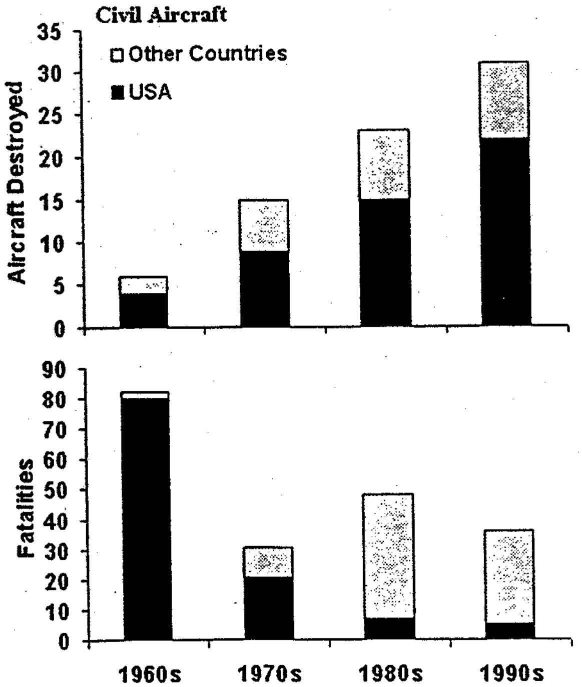

Figure 1 Minimum number of aircraft destroyed and humans killed as a result of civil aircraft collisions with birds and other wildlife, 1960-1999 (from Thorpe [1996, 1993], MacKinnon [1993], and S. E. Wright [U S Department of Agriculture, unpublished data])

Figure 1

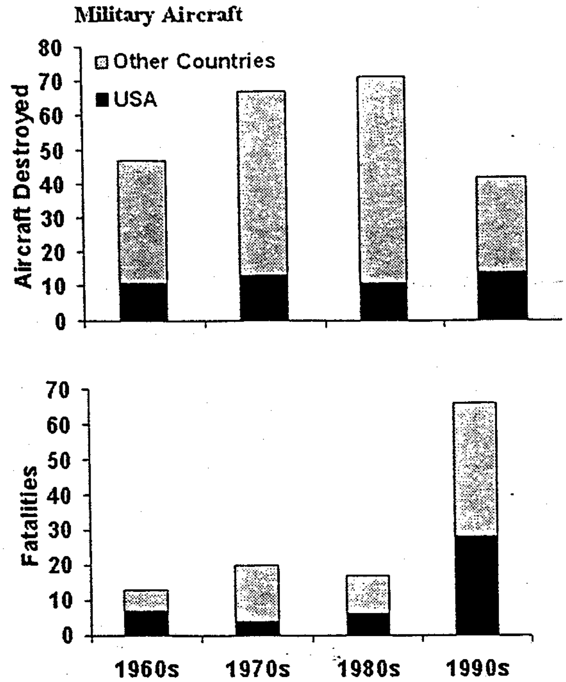

Figure 2. Minimum number of aircraft destroyed and humans killed as a result of military aircraft collisions with birds and other wildlife, 1960-1999 (from Richardson [1994, 1996], Satheseen [1994], and MacKinnon [1998]).

Figure 2

Three major contributors to the increase in the number of wildlife strikes are: 1) increased populations of wildlife species hazardous to aviation, 2) increased air traffic, and 3) changes in types of aircraft.

Increased Populations of Hazardous Wildlife

For the years 1990-1998, waterfowl, gulls and raptors were involved in 77% of the 1,855 damaging strikes where the bird was identified (10). Species such as gulls and Canada geese have adapted to urban and suburban environments making the risk of striking these birds at airports more likely.

The gulls most commonly struck are ring-billed gulls (*Larus delawarensis*) (10). The ring-billed gull population in the USA has increased steadily at a rate of about 6% per year from 1966-1998 (Figure 3) (11).

Canada geese were involved in about 90% of goose strikes to civil aircraft in the USA from 1990-1998 (10). The resident (non-migratory) Canada goose populations increased at an annual rate of 13% in the USA from 1966-1998 (11). In the central USA, the breeding populations increased from only a few thousand in 1965 to 1.1 million in 1996.

Red-tailed hawks (*Buteo jamaicensis*) accounted for 90% of the identified hawks struck by aircraft in the USA from 1990-1998 (10). In the USA, the red-tailed hawk population increased at an annual rate of 3% from 1966 to 1998 (Figure 4) (11). Turkey vultures (*Cathartes aura*) were involved in 93% of the identified vulture strikes (10). The turkey vulture population has increased at an annual rate of 1% in the USA from 1966 to (11).

Deer have also adapted to urban and airport environments, creating hazards for aircraft. Land-use changes have increased deer habitat, and their population has increased dramatically (Figure 5). In the early 1900s there were only about 100,000 white-tailed deer (*Odocoileus virginianus*) in the USA, but now current estimates place the population at 24 million (12). Airports are often situated in outlying areas and are often surrounded by good deer habitat such as woodlots and agricultural fields, which provide food and cover. Airports are

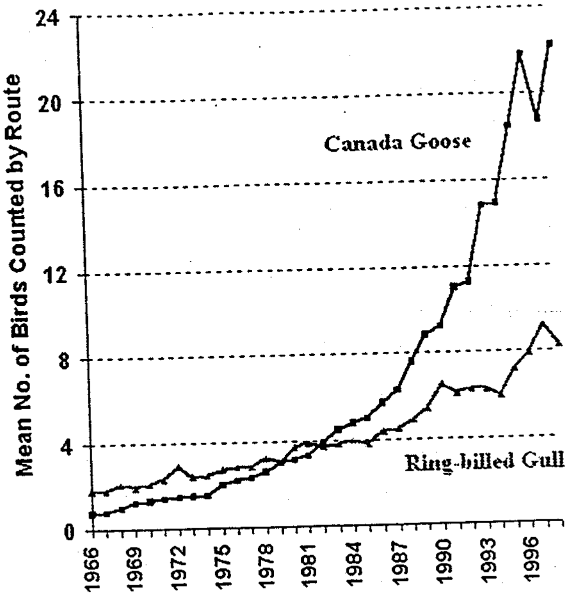

Figure 3. Mean numbers of ring-billed gulls and Canada geese recorded per North American Breeding Bird Survey route in the USA, 1966-1998. Ring-billed gulls and Canada geese were recorded on 350 and 394 routes, respectively (Sauer et al. 1999).

Figure 3

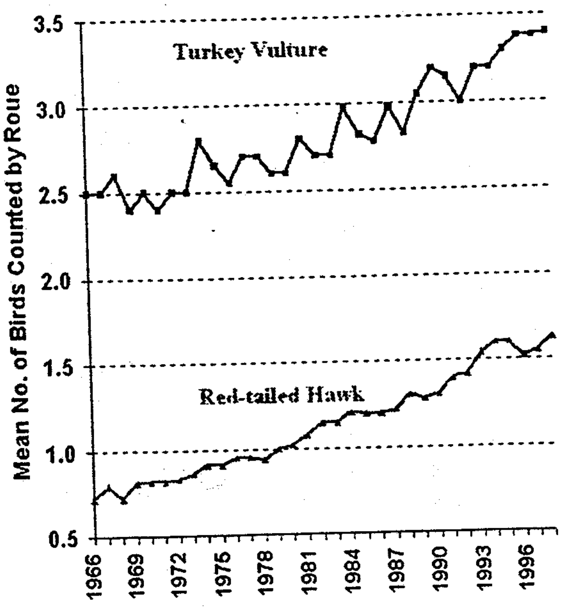

Figure 4. Mean numbers of red-tailed hawks and turkey vultures recorded per North American Breeding Bird Survey route in the USA, 1966-1998. Red-tailed hawks and turkey vultures were recorded on 2,371 and 1,760 routes, respectively (Sauer et al. 1999).

Figure 4

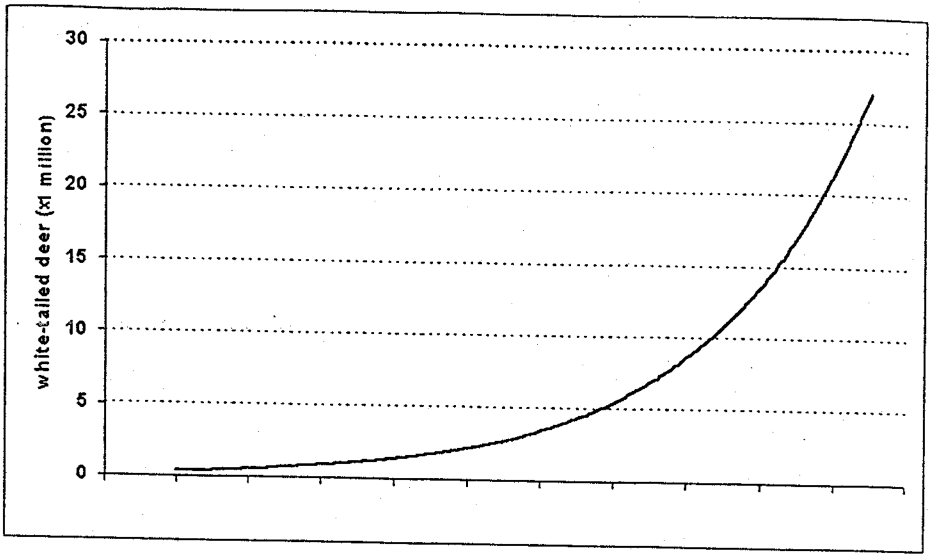

Figure 5. Growth of the white-tailed deer population in the USA, 1900-1995.

Figure 5

prime locations for grazing because they are planted with grasses and other plants that attract deer. Although deer only account for 3% of wildlife strikes with aircraft, they cause damage in 81% of these incidents. The most expensive deer strike reported involved a Hawker-Siddeley, which incurred $1.4 million in damage when an engine was torn loose.

Increased Air Traffic

Air traffic has increased substantially since 1980 in the USA (13). Passenger emplanements increased from 305 million in 1980 to 680 million in 1998. Commercial air traffic increased from 17.8 million aircraft movements in 1980 to 28 million in 1998. Projections predict increases at current levels of growth through the year 2005 (Figure 6).

Changes in Types of Aircraft

Coupled with the increased growth of air traffic is a change in the type of commercial aircraft being used. The newer turbojet-powered aircraft are quieter and faster than the propeller and turboprop-powered aircraft. Therefore, birds and other wildlife are more likely to be struck because they cannot detect the newer aircraft as quickly and have less time to get out of the way.

The higher speed increases the amount of damage that will occur from a bird strike. At 50 knots, a four-pound bird produces an impact of about 14,000 foot-pounds. The force of a bird strike is the function of the square of the speed (8). In addition, multiple-engine damage from ingesting flocks of birds is a growing concern as two-engine aircraft are replacing the three- and four-engine aircraft. In 1969, 75% of the large commercial aircraft in the USA had three or four engines, now about 72% have two engines (Figure 7) (14).

Curtis (15), after analyzing past wildlife strikes and projected air traffic growth, concluded that there is a 25% probability for the loss of a large commercial jet to a bird strike in North America in the next 10 years. However, there are actions that can be taken to reduce this threat.

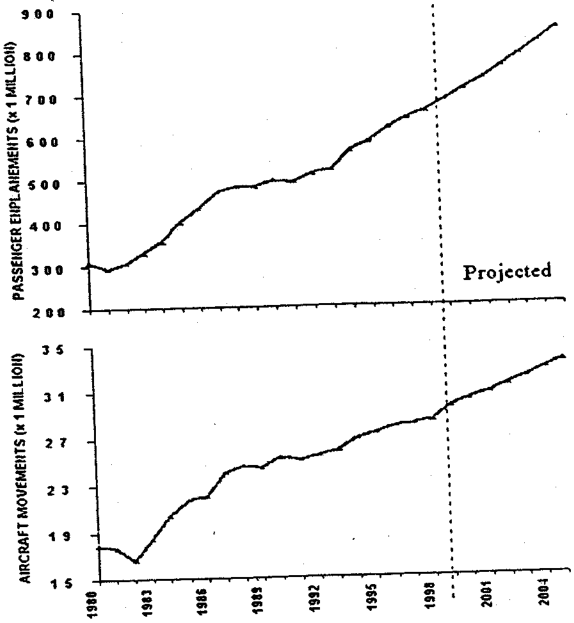

Figure 6. Commercial air traffic activity (movement = arrival or departure) and number of passenger enplanements in the USA, 1980-1998, and projected numbers for 1999-2005. The number of movements increased by 58% (10.4 million) from 1980-1998 or 2.6%/year. During the same time, the number of enplanements increased by 110% (342 million) or 4.2%/year (from FAA 1999)

Figure 6

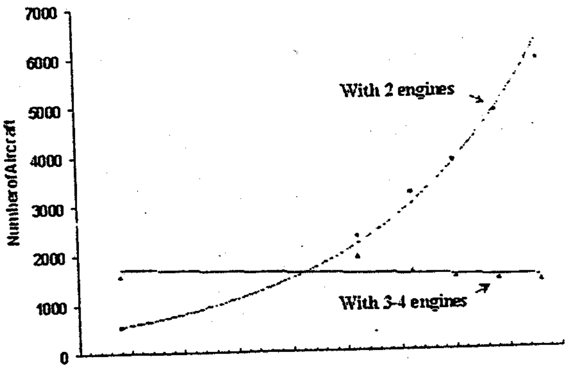

Figure 7. Number of USA-registered commercial aircraft with 2 engines and 3-4 engines, 1969-1998 and projected numbers, 1999-2010 (From J. Goglia [National Transportation Safety Board, Personnel Communication] and Lampl [1998])

Figure 7

What Can Be Done to Reduce the Strike Threat?

Airports with known wildlife hazards, or nearby habitats that attract wildlife, will need to develop comprehensive and professionally implemented wildlife hazard management plans to reduce liability exposure in the aftermath of wildlife strikes. As a recent example, in 1998, the Port Authority of New York and New Jersey paid Air France $5.3 million in an out-of-court settlement for damage to two engines on a Concorde that struck Canada geese during landing at John F. Kennedy International Airport in 1995 (16).

Airport managers, air traffic controllers, and pilots all play a role in the solutions. Since most strikes occur in and around the airport environment, the airport manager can make a significant impact in controlling the strike problem (17). Airport managers are responsible for mitigating wildlife hazards on the airport (Title 14 Code of Federal Regulations part 139.337). This includes reviewing all strike incidents, assessment of wildlife in the airport environment and assessment of wildlife habitat. Not only the airport facility, but the surrounding environment (e.g. landfills, wetlands, agricultural fields, wildlife refuges) must also be considered when trying to reduce habitat that is attractive to hazardous wildlife species. Airport managers can obtain guidance from the U.S. Department of Agriculture's (USDA) Wildlife Services program, which provided assistance to 363 airports in 1999 (18).

A recent publication, "Wildlife Hazard Management at Airports, a manual for airport personnel" produced in cooperation between the FAA and the USDA, is an excellent reference for airport managers and community officials with responsibilities for airport management (19). The manual addresses: 1) wildlife hazards at airports, 2) agencies/organizations impacting wildlife hazard management at airports, 3) federal regulations and departmental policies impacting airport wildlife management, 4) requirements for wildlife hazard assessments/ management plans, 5) methods to reduce hazards, 6) wildlife control programs and, 7) wildlife hazard management training for airport personnel. Copies of the manual can be obtained from the FAA's wildlife hazard Web site (www.faa.gov/arp/hazard.htm) or by writing to New Orders, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15270-7954.

Tower personnel should warn pilots of bird activity, offer alternate runways and delay flights if necessary when wildlife is seen on or near runways. Air traffic controllers can also fill out strike reports by gathering information from pilots who call to report strikes.

Pilots need to be cautious of wildlife on or near runways and avoid landing or taking off if possible when wildlife are present. They should notify Air Traffic Control of wildlife hazards seen while in flight or on the runway. If a strike occurs, it is important (and a recent recommendation by the National Transportation Safety Board [NTSB]) that pilots fill out a strike report. This can be done on the Internet (www.faa.gov/arp/birdstrike). It is vital that all details of bird strike are reported. Without reliable reporting, the true effect of bird strikes cannot be assessed and the necessary counter measures adopted.

Pilot reports help in determining which wildlife species are responsible for damaging strikes. When possible, feathers should be included with reports to aid in the identification of species struck. The reports help make airports aware of wildlife problems, which help justify funding for controlling wildlife. The strike reports provide data that can be used in designing stronger aircraft components. In addition, information from the strike database can be used to help convince the public that wildlife must be controlled in the airport environment.

The NTSB recently examined the wildlife strike problem and made recommendations for actions to reduce damaging strikes (20). This investigation was prompted by two strike incidents in February and March 1999 in which two-engine commercial jets encountered flocks of birds (starlings and snow geese) that damaged both engines on each aircraft.

In the NTSB's final report issued on November 19, 1999, they made nine recommendations to the FAA. These recommendations are summarized below.

1. Evaluate the potential for using radar to provide civil Air Traffic Control personnel and flight crews with near real-time warnings of bird migration and movement activity (Avian Hazard Advisory System [AHAS]) and if found feasible, implement AHAS in high-risk areas such as major hub airports and along migratory routes.

2. Coordinate with the USDA to conduct research to determine the effectiveness and limitations of existing and potential bird hazard reduction techniques.

3. In consultation with the USDA, require that wildlife hazard assessments be conducted at all airports holding an Airport Operating Certificate issued under 14 Code of Federal Regulations, Part 139 where such assessments have not been previously conducted.

4. Require the development of a wildlife hazard management program for all airports determined to need one as a result of the wildlife hazard assessment proposed in recommendation #3 above.

5. Ensure that the wildlife hazard management programs are incorporated into the airport certification manuals and periodically inspect the progress of the programs.

6. Require all airplane operators to report wildlife strikes to the FAA (reports are now voluntary).

7. Contract with an appropriate agency to provide proper identification of bird strike remains (presently, about 50% of reported bird strikes do not provide any information on species). Develop timely procedures for proper bird species identification and ensure that airport and aircraft maintenance employees are familiar with the procedures.

8. Before allowing high-speed, low-level aircraft operations, evaluate the potential risk of increased bird strike hazards to air carrier turbojet aircraft.

9. With representatives from the U.S. departments of the Interior, Agriculture, Defense, and Army Corps of Engineers, convene a task force to establish a permanent bird strike-working group to facilitate conflict resolution and improve communication between aviation safety agencies and wildlife conservation interests.

Rapidly increasing wildlife populations, increasing air traffic and greater numbers of quieter aircraft contribute to the fact that wildlife strikes are likely to increase. However, damage and loss of life from wildlife strikes can be minimized. Because most strikes occur within the airport environment, much can be done to prevent serious accidents. If everyone in the industry cooperates, it is possible we can reduce the chances of a fatal accident resulting from a bird or other wildlife strike.

Anyone interested in learning more about the wildlife strike problem and actions to reduce strikes should contact Bird Strike Committee-USA (BSC-USA) at www.birdstrke.org. BSC-USA meets annually with Bird Strike Committee Canada at a North American airport to discuss the latest technologies in wildlife control at airports. The 2000 meeting will be at Minneapolis St. Paul International Airport, 8–10 August.

Biographical Sketches

Sandra E. Wright

Sandy Wright has worked for the U.S. Department of Agriculture, National Wildlife Research Center in Sandusky, Ohio since 1995 as the FAA Wildlife Strike Database Manager. She is the treasurer of the local EAA Chapter and has co-piloted on countless trips in a Piper Cherokee. Sandy has written several articles, presented talks and generally promotes an awareness of the need for reporting wildlife strikes. She works closely with the FAA biologist in Washington, D.C. and field biologists working to reduce the wildlife threat at airports. She received degrees from Northern Illinois University (B.S., Education) and Chicago State University (M.S., Education).

Richard A. Dolbeer

Richard A. Dolbeer is a senior scientist and project leader with the National Wildlife Research Center of the U. S. Department of Agriculture's Wildlife Services program. He has been head of the Center's Ohio Field Station for the past 27 years where he has led a series of research programs to resolve wildlife-human conflicts ranging from blackbird depredations in grain crops to bird ingestions into aircraft engines. Dr. Dolbeer's research has covered population dynamics of pest species, economic assessment of losses, development of practical management techniques for resolving conflicts, and integrated pest management programs in the United States and abroad. He has published over 100 scientific papers and book chapters. He is a past Associate Editor of the Journal of Wildlife Management and currently serves as Chairperson of Bird Strike Committee USA as well as on the Applied Ornithology committee of the International Ornithological Congress. Richard received degrees from the University of the South (B.A., Biology), the University of Tennessee (M.S., Zoology) and Colorado State University (Ph.D., Wildlife Biology).♦

References

1. Dolbeer, Richard A. "Birds and Aircraft: Fighting for Airspace in Crowded Skies." In Proceedings of the 19th Vertebrate Pest Conference. Edited by A. Charles Crabb. Davis, California, USA: University of California. 2000.

2. MacKinnon, Bruce. 1998. "A reminder about bird strikes." Transport Canada, Safety and Security. Aviation Safety Letter 2/98:10-11.

3. Richardson, W. John. 1994. Serious bird strike related accidents to military aircraft of 10 countries: preliminary analysis of circumstances. Proceedings Bird Strike Committee Europe: 22:129-152.

4. Richardson, W. John. 1996. Serious birdstrike-related accidents to military aircraft of Europe and Israel: list and analysis of circumstances. Proceedings International Bird Strike Committee: 23:33-56.

5. Satheesan, S. M. 1994. The more serious vulture hits to military aircraft in India between 1980 and 1994. Proceedings Bird Strike Committee Europe: 22:163-168.

6. Thorpe, John. 1996. Fatalities and destroyed aircraft due to bird strikes, 1912-1995. Proceedings International Bird Strike Committee 24:11-22.

7. Thorpe, John. 1998. The implications of recent birdstrike accidents and multiple engine ingestions. Proceedings Bird Strike Committee Europe 23:17-31.

8. Transport Canada Aviation. 1996. "Birds." Aviation Safety Letter 3/96:1-3.

9. Wright, Sandra E. Unpublished data from FAA Wildlife Strike database. U. S. Dept. of Agriculture, Sandusky, OH.

10. Cleary, Edward C., Sandra E. Wright and Richard A. Dolbeer. 1999. Wildlife Strikes to Civil Aircraft in the United States 1990-1998. Federal Aviation Administration, Wildlife Strike Database Serial Report #5, Office of Airport Safety and Standards, Washington, D.C. 29 pages.

11. Sauer, John R., James E. Hines, Ian Thomas, Jane Fallon, and Gregory Gough. 1999. The North American Breeding Bird Survey, Results and Analysis 1966-1998. Version 98.1, Patuxent Wildlife Research Center, Laurel, Maryland.

12. Jacobson, Harry A., and James C. Kroll. 1994. The white-tailed deer—the most managed and mismanaged species. Presented at Third International Congress on The Biology of Deer, 28 August–2 September 1994, Edinburgh, Scotland.

13. FAA. 1999. Terminal area forecast (TAF) system. Federal Aviation Administration. Washington, D.C. (http://api.hq.faa.gov/apo/).

14. Lampl, Richard (Editor). 1998. The aviation and aerospace almanac 1998. Aviation Week Group Newsletters, McGraw-Hill Companies. Washington, D.C. 1,022 pages.

15. Curtis, Todd. 1999. Raising public awareness of bird strike risk issues with an enhanced Bird Strike Committee-USA web site. Pages 45-56 in Proceedings Bird Strike Committee-USA/Canada meeting, 10-13 May 1999. Vancouver, BC, Canada.

16. Frank, Al. 1998. Geese at airport cost P.A. $5 million. Star-ledger, Newark, New Jersey. 9 November 1998; pages 1,6.

17. Rao, Arun and Alistair Pinos. "Bird strike threat is best countered by effective wildlife control augmented by land-use management." ICAO Journal Volume 53:4 (October 1998):5-6, 25.

18. Animal and Plant Health Inspection Service. 1999. FY 1999 Annual Program Performance Report. Washington, D.C.

19. Cleary, Edward C. and Richard A. Dolbeer. 1999. Wildlife Hazard Management at Airports: a manual for airport personnel. Federal Aviation Administration, Office of Airport Safety and Standards, Washington, D.C. 248 pages.

20. NTSB. 1999. Safety recommendations A-99-86 to A-99-94. Report to Administrator, Federal Aviation Administration by National Transportation Safety Board, Washington, D.C., 19 November 1999.

21. International Civil Aviation Organization. "Manual on the ICAO Bird Strike Information System (IBIS)." 1989. Third Edition. Doc. 9332-AN/909.

Additional material follows on pages 45–52.

Table 1. Number of Reported Wildlife Strikes to Civil Aircraft, USA, 1990–1998 (10).

Year	No. of Strikes
1990	1721
1991	2064
1992	2275
1993	2317
1994	2380
1995	2526
1996	2696
1997	3381
1998	3575
Total	22,935

Table 2. Number of Reported Strikes to Civil Aircraft by Type of Operator, USA, 1990–1998 (10).

Operator	9-yr. Total	% of Total Known
Commercial	16,611	81
Business	2,814	14
Private	961	5
Government / police	88	<1
Total Known	20,474	100
Total Unknown	2461	
Grand Total	22,935	

Table 3. Number of Reported Wildlife Strikes to Civil Aircraft by Month, USA, 1990–1998 (10).

	Birds		Mammals	
Month	9-yr. Total	% of Total	9-yr. Total	% of total
Jan	872	4	29	5
Feb	806	4	16	3
Mar	1,244	6	38	7
Apr	1,415	6	30	5
May	1,983	9	32	6
June	1,559	7	48	8
July	2,280	10	51	9
Aug	3,024	14	49	8
Sep	3,147	14	63	11
Oct	2,975	13	81	14
Nov	1,879	8	100	17
Dec	1,136	5	43	7
Total	22,320	100	580	100

Table 4. Reported Phase of Flight at Time of Wildlife Strikes to Civil Aircraft, USA, 1990–1998 (10).

	Birds		Mammals	
Phase of Flight	9-yr. Total	% of Total Known Total	9-yr. Total	% of Known Total
Parked	872	4	29	5
Taxi	806	4	16	3
Takeoff	1,244	6	38	7
Climb	1,415	6	30	5
En route	1,983	9	32	6
Descent	1,559	7	48	8
Approach	2,280	10	51	9
Landing roll	3,024	14	49	8
Total Known	22,320	100	494	100
Total Unknown	2,592		86	
Grand Total	22,320		580	

Table 5. Number of Reported Bird Strikes to Civil Aircraft by Altitude (feet) Above Ground Level (AGL), USA, 1990–1998 (10).

Altitude of Strike (feet AGL)	9-yr. Total	% of Known Total	Cumulative % of Known Total
0 to 0	7,177	40	39.9
1 to 99	2,786	15	55.3
100 to 199	1,226	7	62.1
200 to 299	813	5	66.6
300 to 399	571	3	69.8
400 to 499	328	2	71.6
500 to 599	607	3	75.0
600 to 699	189	1	76.1
700 to 799	137	1	76.8
800 to 899	259	1	78.3
900 to 999	111	1	78.9
1,000 to 1,499	887	5	83.8
1,500 to 1,999	579	3	87.0
2,000 to 2,999	720	4	91.0
3,000 to 3,999	520	3	93.9
4,000 to 4,999	332	2	95.7
5,000 to 9,999	614	3	99.2
10,000 to 19,999	145	1	99.99
20,000 to 29,999	8	<1	100
30,000 +	7	<1	100.0
Total Known	18,016	100	
Total Unknown	4,304		
Grand Total	22,320		

Table 6. Civil Aircraft Components Reported as Being Struck and Damaged by Wildlife, USA, 1990–1998 (10).

Component	Birds 9-yr. Total	Mammals 9-yr. Total
Radome		
Struck	2,149	6
Damaged	353	5
Windshield		
Struck	3,539	7
Damaged	308	4
Nose		
Struck	2,538	27
Damaged	218	22
Engines		
Struck	3,201	51
Damaged	1,357	49
Propeller		
Struck	722	82
Damaged	86	72
Wing/rotor		
Struck	2,544	63
Damaged	873	65
Fuselage		
Struck	2,107	35
Damaged	136	33
Landing Gear		
Struck	1,049	187
Damaged	147	122
Tail		
Struck	298	21
Damaged	145	24
Lights		
Struck	184	6
Damaged	157	6
Other		
Struck	610	55
Damaged	298	55
Total Struck	18,941	540
Total Damaged	4,078	457
Grand Total	23,019	997

Table 7. Reported Overall Damage[1] Resulting from Wildlife Strikes to Civil Aircraft, USA, 1990–1998 (9).

Damage	9-yr. total	% of Known Total
None	16,283	81
Minor[2]	2,086	10
Minor?[3]	400	2
Substantial[4]	1,268	6
Destroyed[5]	19	<1
Total Known	20,056	100
Total Unknown	2,879	
Grand Total	22,935	

[1] Damage codes follow the *Manual on the ICAO Bird Strike Information System* (21).

[2] Aircraft can be rendered airworthy by simple repairs; extensive inspection not necessary.

[3] Aircraft was damaged, but details as to the extent of damage are lacking.

[4] Aircraft incurs damage or structural failure which adversely affects the structure strength, performance or flight characteristics and which would normally require major repair or replacement of the affected component. Specifically excluded are: bent fairings or cowlings; small dents or puncture holes in the skin; damage to wing tips; antenna, tires or brakes; engine blade damage not requiring blade replacement.

[5] Damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Table 8. Reported Effect-on-flight of Wildlife Strikes to Civil Aircraft, USA. 1990–1998 (10).

	Birds		Mammals	
Effect-on-flight	Total	% of Known Total	Total	% of Known Total
None	13,290	86	135	37
Aborted takeoff	557	4	66	18
Precautionary landing	1,126	7	39	11
Engine shut down	128	<1	8	2
Other	391	3	119	32
Total Known	15,492	100	367	100
Total Unknown	6,828		213	
Grand Total	22,320		580	

Form Approved OMB NO. 2120-0045

U.S. Department of Transportation
Federal Aviation Administration

BIRD / OTHER WILDLIFE STRIKE REPORT

1. Name of Operator	2. Aircraft Make/Model	3. Engine Make/Model
4. Aircraft Registration	5. Date of Incident ___/___/___ Month Day Year	6. Local Time of Incident ☐ Dawn ☐ Dusk ☐ Day ☐ Night ___ HR ___ MIN ☐ AM ☐ PM
7. Airport Name	8. Runway Used	9. Location if En Route (Nearest Town/Reference & State)
10. Height (AGL) feet	11. Speed (IAS) knots	

12. Phase of Flight

- ☐ A. Parked
- ☐ B. Taxi
- ☐ C. Take-off Run
- ☐ D. Climb
- ☐ E. En Route
- ☐ F. Descent
- ☐ G. Approach
- ☐ H. Landing Roll

13. Part(s) of Aircraft Struck or Damaged

	Struck	Damaged		Struck	Damaged
A. Radome	☐	☐	H. Propeller	☐	☐
B. Windshield	☐	☐	I. Wing/Rotor	☐	☐
C. Nose	☐	☐	J. Fuselage	☐	☐
D. Engine No. 1	☐	☐	K. Landing Gear	☐	☐
E. Engine No. 2	☐	☐	L. Tail	☐	☐
F. Engine No. 3	☐	☐	M. Lights	☐	☐
G. Engine No. 4	☐	☐	N. Other: (Specify)	☐	☐

14. Effect on Flight

- ☐ None
- ☐ Aborted Take-Off
- ☐ Precautionary Landing
- ☐ Engines Shut Down
- ☐ Other: (Specify)

15. Sky Condition

- ☐ No Cloud
- ☐ Some Cloud
- ☐ Overcast

16. Precipitation

- ☐ Fog
- ☐ Rain
- ☐ Snow
- ☐ None

17. Bird/Other Wildlife Species

18. Number of birds seen and/or struck

Number of Birds	Seen	Struck
1	☐	☐
2-10	☐	☐
11-100	☐	☐
more than 100	☐	☐

19. Size of Bird(s)

- ☐ Small
- ☐ Medium
- ☐ Large

20. Pilot Warned of Birds ☐ Yes ☐ No

21. Remarks (Describe damage, injuries and other pertinent information)

DAMAGE / COST INFORMATION

22. Aircraft time out of service: ______ hours	23. Estimated cost of repairs or replacement (U.S. $) $	24. Estimated other cost (U.S. $) (e.g. loss of revenue, fuel, hotels) $
Reported by (Optional)	Title	Date

Paperwork Reduction Act Statement: The information collected on this form is necessary to allow the Federal Aviation Administration to assess the magnitude and severity of the wildlife-aircraft strike problem in the U.S. The information is used in determining the best management practices for reducing the hazard to aviation safety caused by wildlife-aircraft strikes. We estimate that it will take approximately 5 minutes to complete the form. The information collected is voluntary. Please note that an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control number associated with this collection is 2120-0045

FAA Form 5200-7 (11-97) Supersedes Previous Edition ☆ U.S. GPO: 1997-632-114/74701 NSN: 0052-00-651-9005

Appendix 1

Advice to Flight Crews Concerning the Wildlife Hazard to Aircraft By Air Line Pilots Association, International, Airports, Grounds, and Environment Group 1999

Advice to Flight Crews Concerning the Wildlife Hazard to Aircraft

Prior to Takeoff

- If you see wildlife such as birds or deer on or near the runway, do not land or take off on that runway until the wildlife are safely dispersed (a delay may be required which is similar in length to that experienced if thunderstorm activity were present in your flight path). In the USA, the airport manager is responsible under FAR Part 139 to mitigate wildlife hazards on the airport. Many other nations have similar regulations or requirements of airport management to mitigate wildlife hazards. The airport manager should have a plan of action and operations people who are trained on techniques for wildlife dispersal and available to do so.
- Do not expect that birds will be responsive to actions you may take to hasten their departure. When loafing on the ground, birds face into the wind, and, therefore, will probably not see your aircraft as it enters the runway or its lights. Airborne weather radar has not demonstrated effect on birds because they do not hear in the x-band frequency. While birds have acute hearing, there is no evidence that they associate noise, such as the spooling up of a jet engine, with any threat – do not expect, therefore, that the spooling up of engines will cause birds to take flight.
- USA pilots are responsible under FAR Part 91 "… to see what can be seen and separate his aircraft from obstructions and hazards, including birds." Therefore, prior to departure, look for wildlife while scanning the runway for other hazards and respond to sightings or verbal warnings of wildlife as you would to other aviation hazards.
- Promptly notify Air Traffic Control personnel when observing wildlife hazards on the airport or in flight. Although paragraph 2-1-22 of FAA Order 7110.65, the Controller's Handbook, requires controllers to issue advisory information on reported bird activity, including type of birds, location and direction of flight, use the word "Pirep" in your report to ensure that controllers are aware that they should alert other aircraft of the hazard.
- When taking off in a string of departures, such as is common at a hub, be particularly cautious when wildlife are in the vicinity. The lead or second aircraft may frighten feeding or loafing birds into becoming airborne over the runway or departure area, becoming a collision risk for following aircraft. This scenario was one of the causal factors in the crash of an E-3 (B-707) in Alaska in 1995. Birds may attempt to return to the spot on the airport from which they were frightened by going into a holding pattern over the airport to wait. Therefore, if the lead aircraft scares flocks of birds into becoming airborne, wait until the flock has cleared the area prior to attempting takeoff.

In Flight

- Over 90% of bird strikes happen below an altitude of 2,300 feet. If taking off in an area of high bird activity, climb as expeditiously as possible. If en route and suddenly confronted with birds, pull up rapidly, consistent with good piloting technique. Birds, when confronted with a collision risk, tend to tuck their wings and dive away from the intruder. However, expect that birds will turn in random directions to avoid a collision when they are close to the ground but they will not descend.

- Consider slowing down if confronted with bird activity. If a collision occurs, a slower speed may minimize the damage as the damaging force is determined by mass times velocity squared. Slower speeds will give the birds more time to react and avoid a collision.
- If wildlife is reported on or near the active runway, request another runway. Avoid flying over locations of known wildlife attractants. Birds like bodies of water, such as airport retention ponds, lakes and seashores. Consider requesting a different route if your assigned route carries you over or near wildlife activity.

Airport Certification

- Although designed to be very strong in many ways, modern aircraft are not capable of protecting the pilot from all wildlife hazards. All modern aircraft fuselages have been penetrated by birds – the B-737 and B-727 appear most susceptible to bird penetrations, especially around the nose area. In 1997, three crewmembers were injured in three separate events when birds struck their cockpit windows. Although the windows were not penetrated, per se, the pilots were injured when the inner pane shattered and showered the pilots with glass shards.
- No jet engine currently operating is certified to ingest even one large goose and continue operating. Geese and swans are social animals and move in flocks. The seriousness of an encounter with large wildlife such as geese, swans, eagles, vultures, etc., cannot be overstated. However, smaller flocking wildlife, such as starlings, which have high body density and often flock by the hundreds or thousands, may have the same effect upon aircraft engines. Engines are certified as a type, not as a system with a particular aircraft. If sufficient numbers of wildlife are encountered, they can and have damaged engines to the point that they must be shut down, or continue operating but with less thrust available than is necessary to remain airborne.

Bird Migration

- In North America, a migration of over 300 million birds takes place in the spring and fall each year. The four main flyways, namely, the Atlantic, Pacific, Mississippi and Central, follow both coastlines, the Mississippi River and the central plains east of the Rockies. Weather is the key to the start of migration. Nexrad radar can display thousands of flocks of birds headed south in the fall and paralleling strong cold fronts as they move across the country. Migrating birds will often wait on the ground for days for favorable winds aloft. During migration, waterfowl will fly both day and night, depending on weather and winds, and typically as high as 10,000 feet. This semi-annual migration creates additional hazards to aviation as migrating birds join resident airport birds and increase the likelihood of conflict with aircraft.
- Although spring and fall migrations create two peaks of unusual hazards, the other period of increased hazard is late summer as the inexperienced fledglings begin flying and the adult birds molt, shedding their flight feathers, thereby reducing their maneuverability.

Report Wildlife Hazards

- If you encounter wildlife hazards or experience a strike with birds or other wildlife in the USA, submit the appropriate company safety report and an FAA Form 5200-7 Bird Strike Report, in addition to a NASA ASRS report. You can also report on the Internet at (www.faa.gov/arp/birdstrike)
- These reports should be submitted even if no damage is done to your aircraft because they are the basis for documenting problems and for requesting action from appropriate authorities to mitigate wildlife hazards. Without the reports it is difficult or impossible to substantiate the need for improvements.♦

♦♦♦♦